DOCUMENT RESUME

ED 433 197 SE 061 976

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TITLE	Teaching about Biodiversity. ERIC Digest.
INSTITUTION	ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, OH.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO	EDO-SE-98-15
PUB DATE	1998-12-00
NOTE	4p.
CONTRACT	RI93002013
AVAILABLE FROM	ERIC Clearinghouse for Science, Mathematics, and Environmental Education, 1929 Kenny Road, Columbus, OH 43210-1080.
PUB TYPE	ERIC Publications (071) -- ERIC Digests in Full Text (073)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Biological Sciences; Elementary Secondary Education; Higher Education; *Resource Materials; Science Activities; *Science Education; Wildlife; *World Wide Web
IDENTIFIERS	*Biological Diversity; ERIC Digests

ABSTRACT

There are three aspects to biodiversity: (1) genetic diversity within species that enables organisms to evolve and adapt to new conditions; (2) species diversity that refers to the number and kind of organisms distributed within an ecosystem; and (3) ecosystem diversity that refers to the variety of habitats and communities interacting in complex relationships. This digest offers a guide to teaching about biodiversity in the science curriculum. (CCM)

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Through evolutionary processes, the miracle of life has given rise to a rich tapestry of biological diversity; or biodiversity. There are three aspects of biodiversity: (a) genetic diversity within species that enables organisms to evolve and adapt to new conditions, (b) species diversity that refers to the number and kind of organisms distributed within an ecosystem, and (c) ecosystem diversity that refers to the variety of habitats and communities interacting in complex relationships. During earth's history, life has proliferated and diversified, with species filling the myriad niches of ecosystems. Through the many climatic and structural changes of a dynamic earth, life continued to adjust and prosper. Today there are approximately 1.4 million known species (Wilson, 1992, p. 133) with over five million yet to be identified by conservative estimates, living everywhere from the boiling waters of undersea vents to the frozen Antarctic.

Several times in the past—five times, apparently—extinctions occurred on vast scales, with the majority of life forms dying out. These extinction events seem to have been the result of large-scale forces, from shifts of the continental plates to the impact of meteorites and volcanic activity. But the products and patterns of evolution have been repeated each time, with the proportionally few survivors diversifying over millions of years and replenishing the earth, once with reptiles as the dominant animal form, and now with mammals as the dominant form.

As miraculous as the tenacity of life seems to be, however, it is sobering to realize that we seem to be in the midst of the sixth great period of extinction, and we seem to be causing it. What has previously been caused by plate tectonics, volcanoes, meteors, and other forces of nature is now being caused by the rapid destruction of habitats, depletion of resources, and the ecological mixing of incompatible species. Currently, more than 10,000 species become extinct each year (California Academy of Sciences Biodiversity Resource Center, *http://web.calacademy.org/research/library/biodiv.htm*), and approximately 25% of all mammals seem to be heading toward extinction (Tuxill, 1998, p. 21). The good news is that life will surely survive this most recent threat, but the bad news is that it will be millions of years before the next assemblage of diverse species rule the land, air, and sea. This is a troubling story that must be told in powerful ways in schools, so citizens who have a concern for the biological future can act with understanding.

Biodiversity in the Science Curriculum

Biodiversity appears as a key topic in several science education reform documents. Within biology programs, biodiversity is characterized as the product of evolution and has been identified as an essential topic of study for high school, 2-year college, and 4-year college courses (BSCS, 1993, p. 72). The national science education standards include the following principles relating to biodiversity:

Grades 5-12: Diversity and Adaptations

- Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.
- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.
- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Grades 9-12: Biological Evolution

- The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.
- Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.
- The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.
- Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities which reflect their evolutionary relationships. Species is the most fundamental unit of classification.

Beyond the Standards

Though the national standards and other guidelines present biodiversity in the traditional way as an important topic in the life sciences, they do not directly address the importance of biodivesity from either an ecological point of view or quality of life perspective. The concept of biodiversity takes on increased importance and meaning when we think of the many reasons to be concerned about the current threats to biodiversity. As St. Antoine and Runk (1996) point out, it is important to conserve the diversity of life for medical and economic reasons. It is also important to protect the diversity of life because it helps maintain important ecological functions, such as oxygen production, pollination, and flood control, which in turn help support all life on Earth. It has even been suggested that the current biodiversity crisis may lead to the disruption and degradation of several basic processes of evolution (Myers, 1996).

Biodiversity, then, is more than a biology or science topic. It is a concept that cuts across disciplinary boundaries, and it is an environmental issue with board ramifications for the quality of human life. Unfortunately, people seem to lack knowledge about biodiversity, and they fail to perceive a link between species preservation and improved quality of life for humans (Foster-Turley, 1996, p. 5).

Bryant (*http://darwin.bio.uci.edu/~sustain/bio65/lec07/b65lec07.htm*) has identified several benefits of biodiversity conservation, including:

- Potential for broadening our food supplies by developing new crop plants, fish supplies, and animal sources.
- Increased use of biological control agents using natural enemies to control pests.
- Potential sources of genes to improve quality, resistance, and vigor of conventional crops through hybridization and genetic engineering.
- Increased use of natural products for medicines, drugs, and poisons.
- Recognition of environmental services performed by wild organisms, including pollination, biodegradation, soil aeration,

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fertilization, gas exchanges, and water storage.

- Sources of warning signs to offset the lack of health screening tests for many chemicals and pollutants.
- Provision of model systems for basic scientific research.
- Aesthetic value of interesting wildlife and plantlife.
- Future benefits yet to be determined.

It seems evident from reviewing some of the benefits of conserving biodiversity that biodiversity education must go beyond an academic study of biological relationships, structural and functional diversity, and the processes of evolution and extinction. It will become increasingly important for humans to consider the impact of their activities on biodiversity, and to learn ways of slowing the increasing rates of extinction. Beyond gaining an understanding and appreciation of the diversity of living organisms, students must come to understand the connections between biodiversity and our economy, ecological sustainability, environmental quality, and the quality of life. There are issues to study, problems to solve, and decisions to make that require a deepened understanding of biodiversity, and teachers will need to seek out sources of information and activities to engage students with the concept.

Biodiversity Education Materials

A biodiversity education framework has been proposed by Braus and Champeau (1994), and a biodiversity primer has been published by Braus (1994). The primer includes information on the importance of biodiversity to humans, and is suitable for middle school and high school students. A related poster and activity guide is also available (Braus & O'Reilly, 1994).

An extensive review of outstanding biodiversity curricula, multimedia resources, and other educational materials has been produced by the North American Association for Environmental Education (Pitman, Braus, & Asato, 1998). The reviewed materials were examined by teams of teachers, content specialists, and environmental educators, and each item is rated on the basis of six criteria.

For teachers and class groups able to take excursions, the National Park Service (NPS, 1990) developed an environmental education curriculum that focuses on biodiversity. Each of the ten units focuses on a specific concept relating to biodiversity, and each unit combines classroom activities with activities for use in a park area.

A video and companion guide have been produced by the World Wildlife Fund (WWF, 1995). The guide provides summaries of the video segments, and four separate sections focus on the following:

- What is biodiversity?
- Why is biodiversity important?
- Why are we losing biodiversity?
- What are we doing about the loss of biodiversity?

World Wide Web Resources

- **Biodiversity and Conservation**
  http://darwin.bio.uci.edu/~sustain/bio65/Titlpage.htm.
  A hypertext book by P. J. Bryant. The chapters on "Global patterns of biodiversity" and "Values of biodiversity" seem particularly relevant.
- **The Virtual Library of Ecology, Biodiversity, and the Environment**
  http://conbio.rice.edu/vl/browse/
  Serves as a gateway to many other websites related to biodiversity.
- **Biodiversity and Biological Connections Web Server**
  http://muse.bio.cornell.edu/
  Serves as a gateway to extensive lists of websites providing information about specific organisms, professional groups, and other resources.
- **Hall of Biodiversity**
  http://research.amnh.org/biodiversity/index.html
  Resources associated with the Hall of Biodiversity at the American Museum of Natural History.
- **The Tree of Life**
  http://phylogeny.arizona.edu/tree/phylogeny.html
  The gateway to an extensive, distributed Internet project with information about biodiversity.
- **Forests and Biodiversity**
  http://www.igc.apc.org/wri/enved/trends/for-home.html
  This page is associated with the World Resources Institute.
- **Forests and Biodiversity Links**
  http://forests.org/forsite.html
  An extensive collection of links catgegorized into "biodiversity," "sustainable forestry," and many other topics.
- **World Resources Institute: Biodiversity**
  http://www.wri.org/biodiv/index.html
  An extensive collection of sites relating to biodiversity.
- **National Biodiversity Profiles**
  http://www.wcmc.org.uk:80/nbp/
  Enables users to search for biodiversity information and highlights for specific countries.
- **EE-Link Endangered Species**
  http://eelink.net/EndSpp/Endangered.html
  Provides access to images, policies, information, links, and other resources.
- **National GAP Analysis Program**
  http://www.gap.uidaho.edu/gap/
  A USGS site on A Geographic Approach to Planning for Biological Diversity
- **Biodiversity Programs**
  http://nmnhwww.si.edu/biodiversity/biopro.htm
  Describes various biodiversity programs of the Smithsonian Institution.
- **Environment Australia: Biodiversity Group**
  http://www.anca.gov.au/
  Provides access to publications, programs, and information servers.

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EDO-SE-98-15

This digest was funded by the Office of Educational Research and Improvement, U.S. Department of Education under contract no. RI-93002013. Opinions expressed in this digest do not necessarily reflect the positions or policies of OERI or the Department of Education.

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